



Jet Propulsion Laboratory
California Institute of Technology

Exoplanet Exploration Program Update

Kendra Short, Deputy Program Manager

January 3, 2020

ExEP Updates Throughout the Agenda

- Day 1 – Friday
 - HQ Update – Doug Hudgins
 - Program Update – Kendra Short
 - Science Update – Karl Stapelfeldt
 - Technology Update – Nick Siegler
 - Standards Team Final Report – Rhonda Morgan
 - EPRV Initiative – Jenn Burt & Scott Gaudi
- Day 2 – Saturday
 - ExoPAG Suggestions for Actions – Gary Blackwood

ExEP Splinter Session: "Imaging Habitable Exoplanets: Are We Ready?"
***RESCHEDULED* (Sunday, Jan. 5, 2020; 1:55-3:30pm HST, 306AB)**

NASA Exoplanet Exploration Program

Astrophysics Division, NASA Science Mission Directorate

NASA's search for habitable planets and life beyond our solar system



Program purpose described in 2014 NASA Science Plan

1. Discover planets around other stars
2. Characterize their properties
3. Identify candidates that could harbor life

ExEP serves the Science Community and NASA:

- Focal point for exoplanet science and technology
- Integration of cohesive strategy for future discoveries

<https://exoplanets.nasa.gov>

Exoplanet Missions

NASA Missions

Non-NASA Missions

Hubble¹

Spitzer

Kepler

TESS

JWST²

WFIRST

ARIEL (CASE)

PLATO

LUVOIR⁵

CHEOPS⁴

Gaia

CoRoT³

Starshade
Rendezvous⁵

HabEx⁵

OST⁵

W. M. Keck Observatory

Large Binocular
Telescope

WIYN

SMARTS 1.5m⁶

AAT

Ground Telescopes with NASA participation

⁵ 2020 Decadal Survey Studies

⁶ NSF Partnership (NN-EXPLORE)

- ¹ NASA/ESA Partnership
- ² NASA/ESA/CSA Partnership
- ³ CNES/ESA
- ⁴ ESA/Swiss Space Office

NASA Exoplanet Exploration Program

Space Missions and Concept Studies

Kepler K2



Large- and Probe-Scale
Mission Concepts

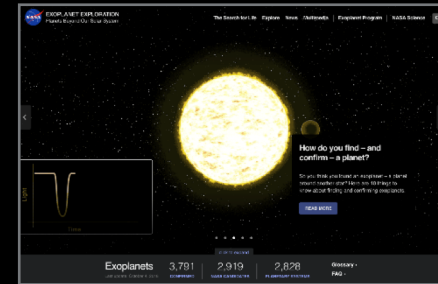


Coronagraph



Starshade

Exoplanet Communications

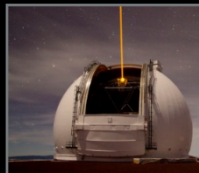


Science Research & Technology

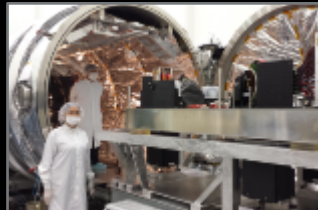
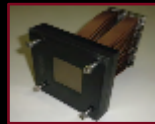
Key Sustaining Research



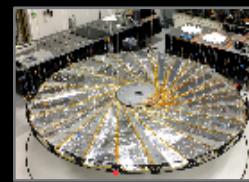
NN-EXPLORE



Keck Observatory



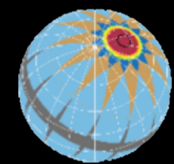
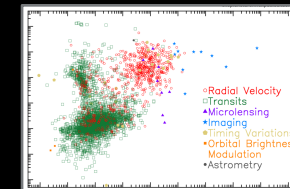
Coronagraph
Technology
Development



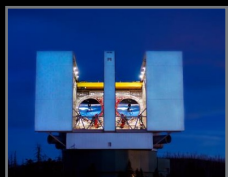
Starshade
Technology
Development (S5)

Technology Development

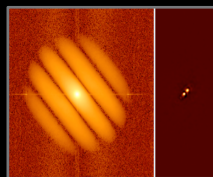
NASA Exoplanet Science Institute (NExSci)



Archives, Tools, Sagan Program,
Professional Engagement



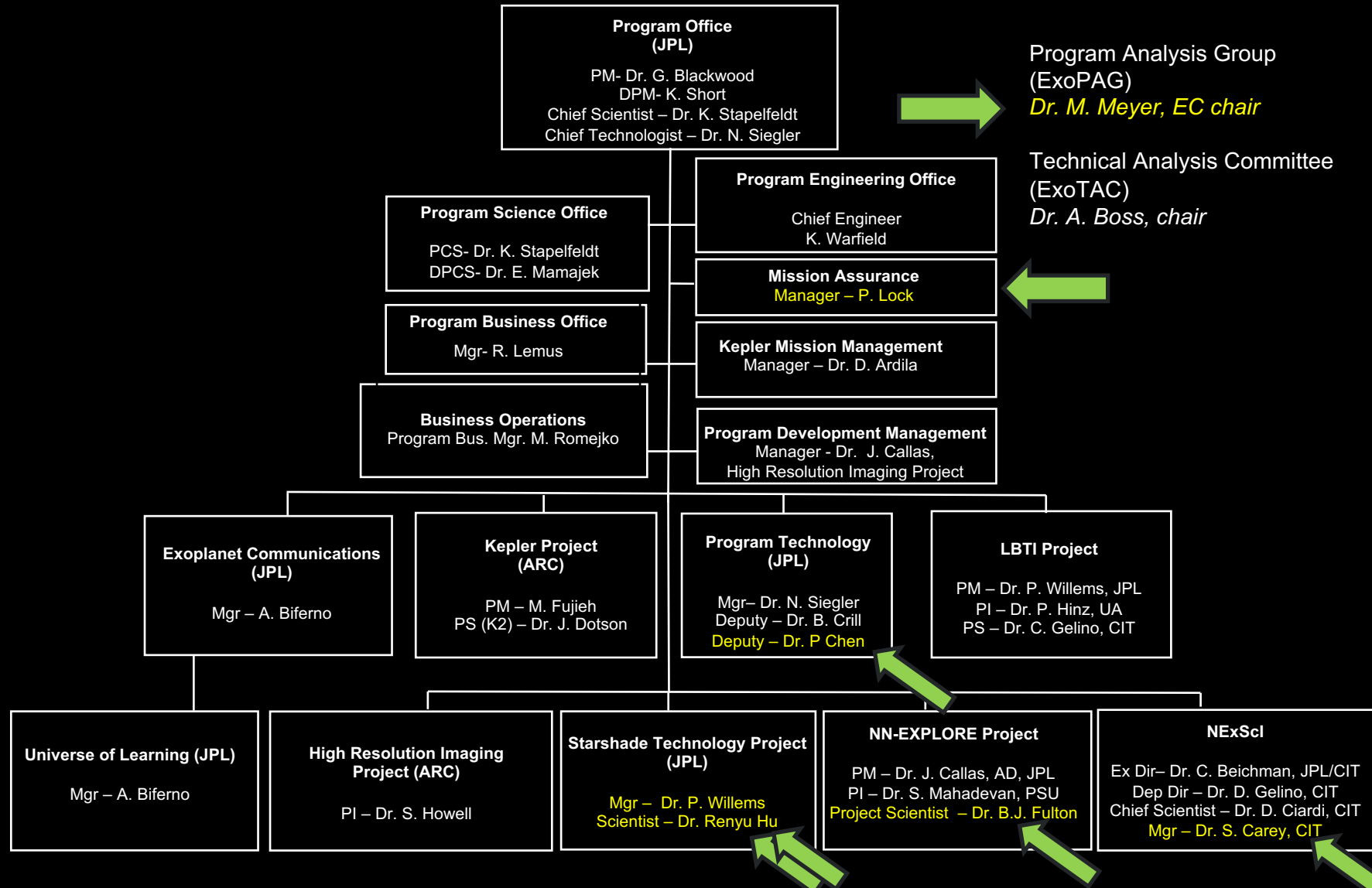
Large Binocular
Telescope
Interferometer



High Resolution
Imaging

NASA Exoplanet Exploration Program

Astrophysics Division, Science Mission Directorate

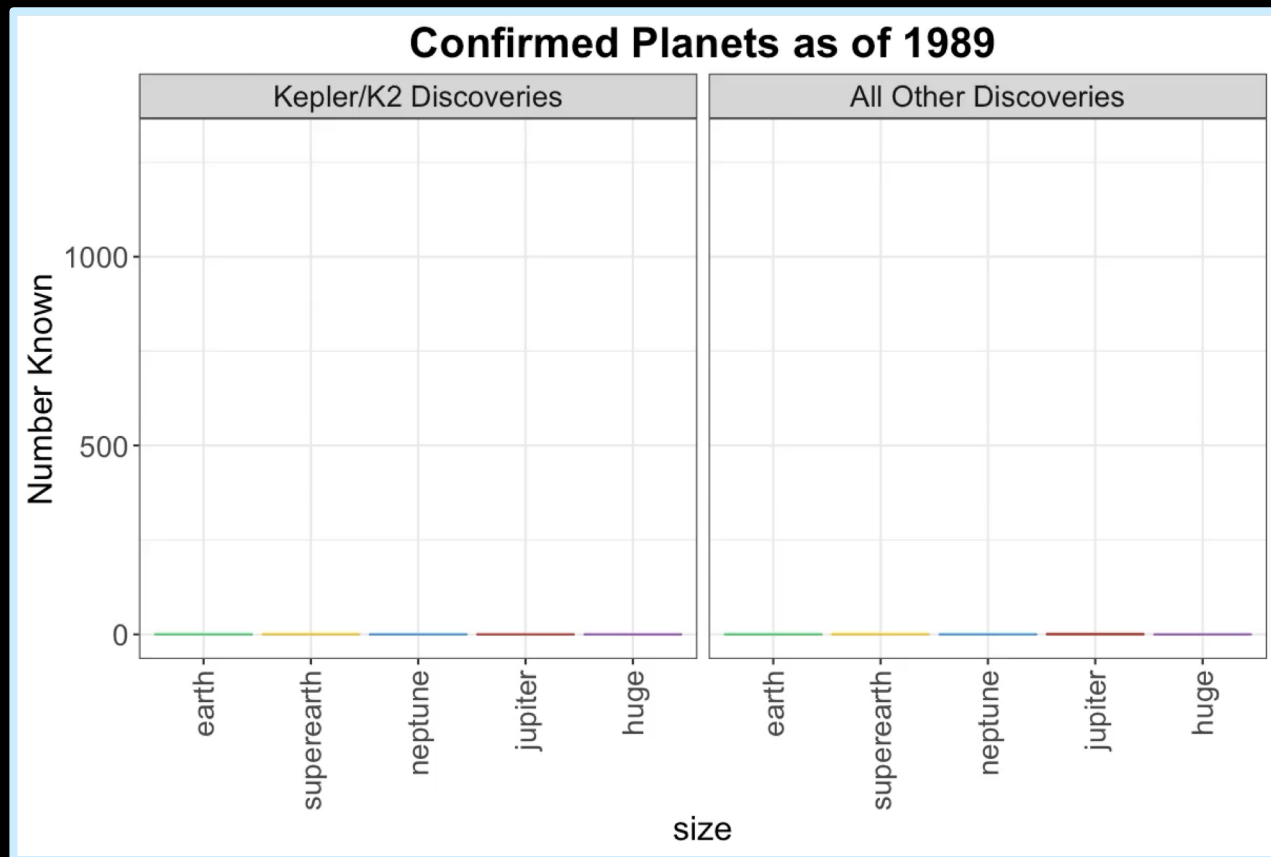


We Are Your ExEP



Kepler/K2 Highlights

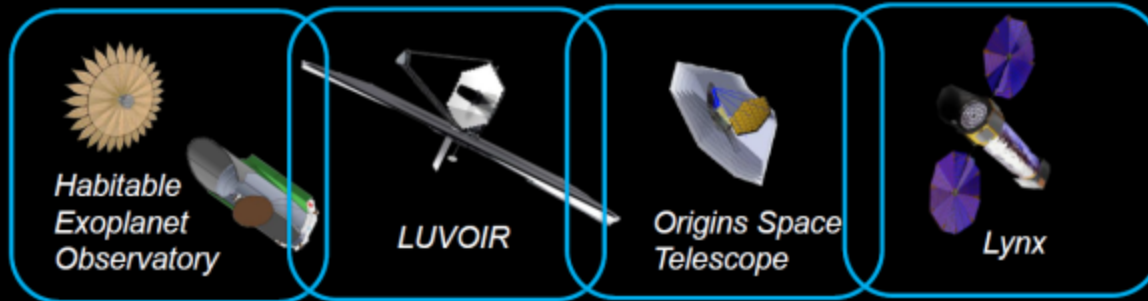
- Wrapping up reprocessing of K2 Campaign data
- Orderly close out of project and science offices
- Celebrating discoveries and impact of Kepler/K2 science



ExEP Support for Decadal Preparations

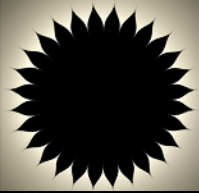
- ExEP support for large decadal studies and probes studies
- Program Office technologists (ExEP, PCOS/COR) conducted three rounds of TRL assessments of the STDT designs
- Standards Definition and Evaluation Team for “common yardstick” yield comparison
- Special studies: Remote Occulter, Lunar Farside, Starshade Rendezvous Probe “delta-study” to reflect CGI design change

Large Scale Mission Concepts

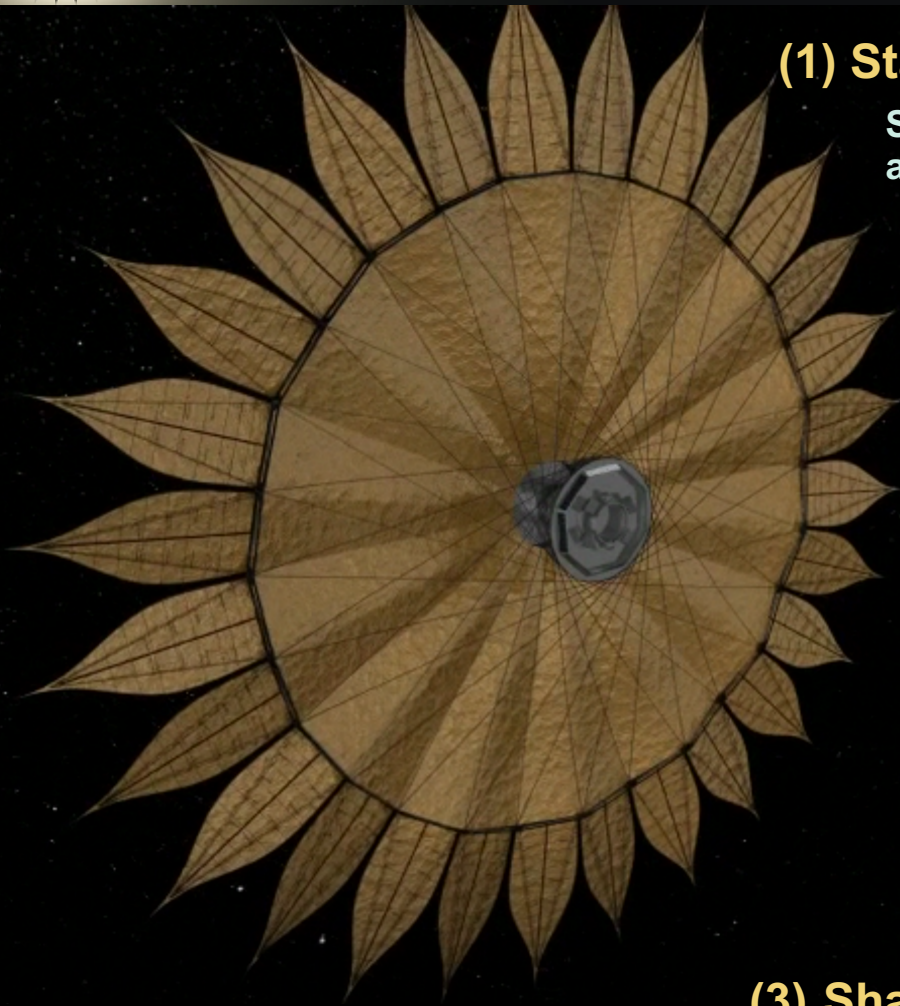


Exoplanet Medium Scale Concepts





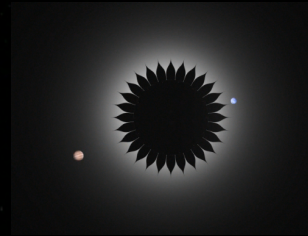
Starshade Technology Gaps



(1) Starlight Suppression

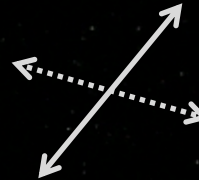
Suppressing diffracted light from on-axis starlight and optical modeling

Suppressing scattered light off petal edges from off-axis Sunlight



(2) Formation Sensing

Sensing the lateral offset between the spacecraft

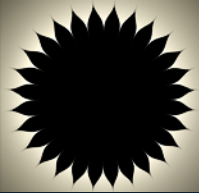


(3) Shape Accuracy and Shape Stability

Fabricating and positioning the petals to high accuracy

Maintaining shape stability over operational conditions





S5 Technology Milestones Scorecard

Complete March 2020



Complete June 2023

Starlight
Suppression



Scattered
Sunlight



Formation Flying



Critical Features

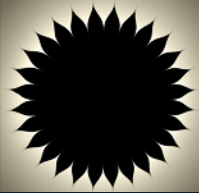
All Features

Shape Accuracy



Shape Stability





Science and Industry Partnership within S5

S5 Technology Development

Close the technology gaps and advance individual technologies to TRL 5

- Petal shape accuracy and stability
- Contrast performance and optical model validation
- Solar glint
- Lateral sensing for formation flying

Science and Industry Partnership

- Maximize the technology readiness of starshades
- Complement the work of S5 technology development plan

TSWG

Forums

Small
Business
Partners



Starshade Science and Industry Partnership (SIP) Technology and Science Working Group (TSWG)

Last Name	First Name	Institution
Arenberg	Jon	Northrop Grumman Aerospace Systems
d'Amico **	Simone	Stanford University
Harness	Anthony	Princeton University
Jensen-Clem	Becky	UC Berkeley
Mather	John	NASA Goddard Spaceflight Center
Romero-Wolf	Andrew	NASA Jet Propulsion Laboratory
Seager	Sara	Massachusetts Institute of Technology
Stahl	Phil	NASA Marshall Space Flight Center
Turnbull	Margaret	SETI Institute
Witkowski	Allen	Katabasis Engineering

** TSWG Chair



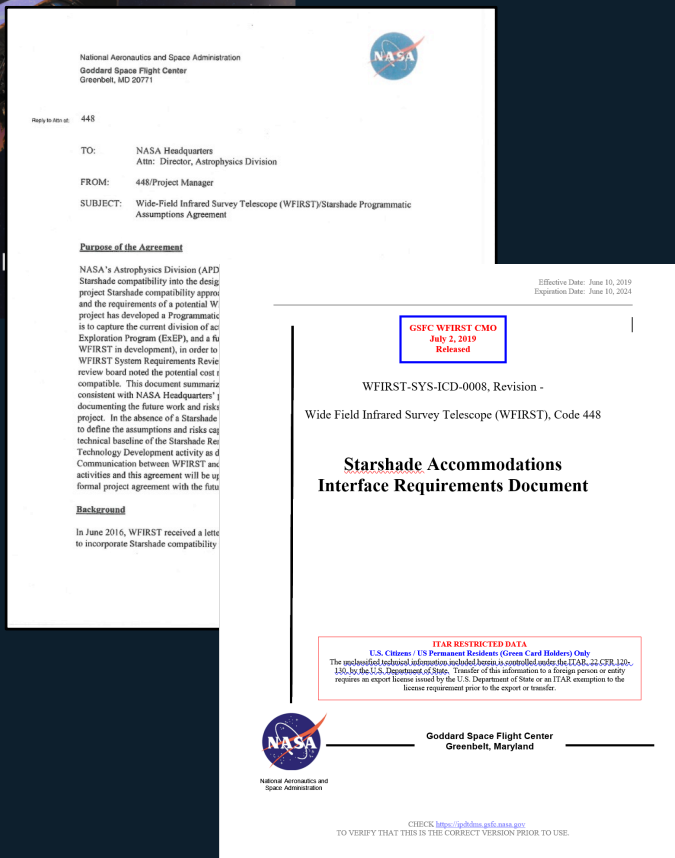
Upcoming SIP Face to Face Meeting

Date: February 6-7, 2020

Please save the date for the second Starshade SIP forum on **February 6-7**, to be held in **Boulder, Colorado**.

WFIRST - Starshade Accommodation

Starshade Rendezvous Probe



WFIRST – Starshade Accommodation

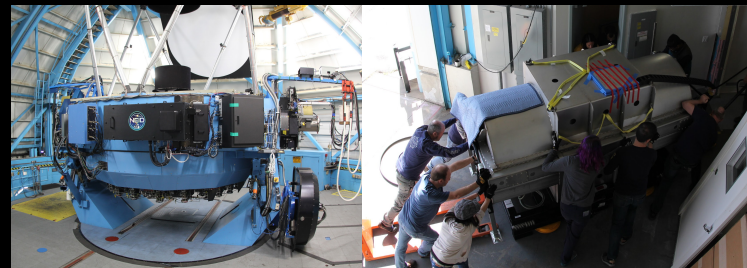
Represent the Starshade-side of the interface to support the WFIRST project in meeting “starshade ready” requirement.

- Programmatic Assumptions Agreement
- Level 2 Technical Interface Requirements Document
- Requirements for Spacecraft “starshade” hardware (SAC, S-band)
- Starshade optical hardware in CGI
- Functional requirements of CGI subsystems for “starshade mode”

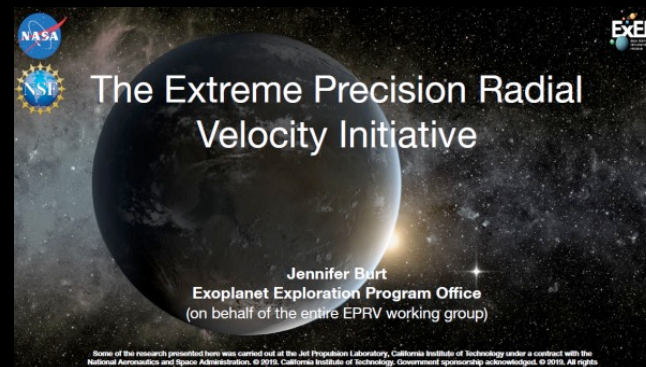
NNEXPLORE - Activities

NASA-NSF Exoplanet Observational Research partnership

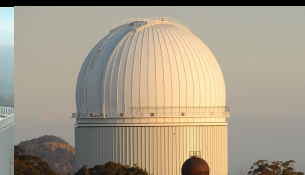
- NEID Instrument Hardware is delivered and installed on the WIYN Telescope
 - Port Adapter delivered to Kitt Peak 10/15/19
 - NEID delivered to Kitt Peak 10/28/19
 - First 2019B shared-risk GO observing started 12/29/19 (10 awards)
- EPRV Working Group
 - Last Face to Face Jan 2020
 - Recommendation due to APD March 2020
- Access to RV facilities in Southern Hemisphere
 - SMARTS/Chiron
 - AAT/Veloce



Port Adapter from Univ of Wisconsin and NEID spectrograph from Penn State





SMARTS 1.5m



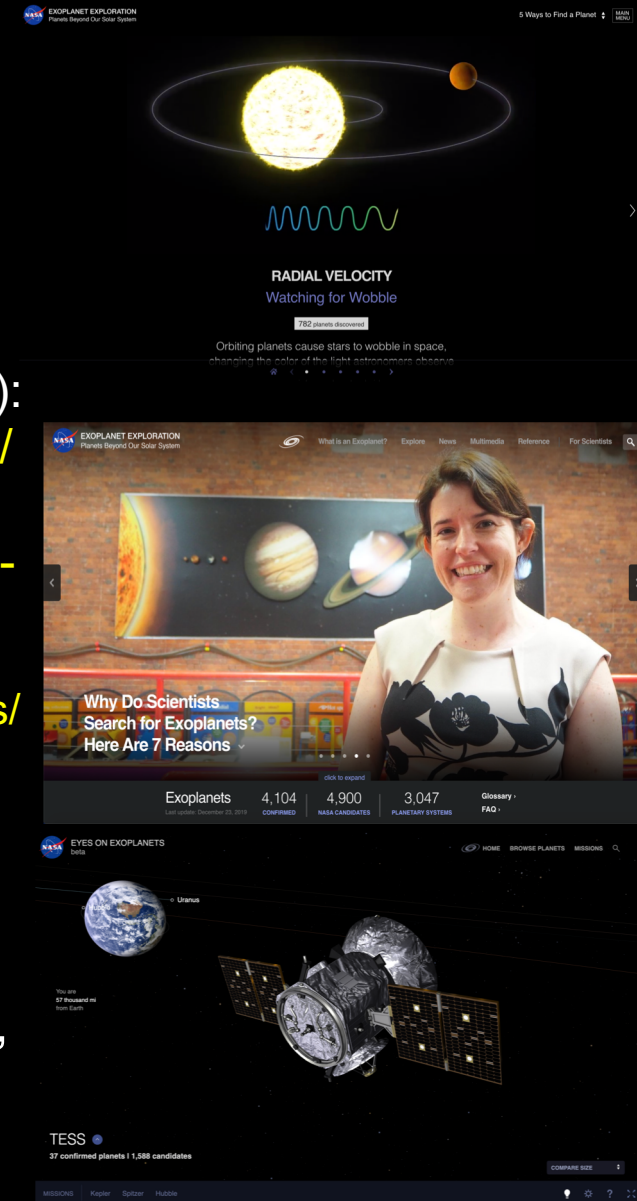
AAT

<https://exoplanets.nasa.gov/exep/NNExplore/>

ExoComm Cheat Sheet

- Website: <https://exoplanets.nasa.gov/>
 - Planet Counter
 - Eyes on Exoplanets
 - Multimedia Gallery
 - 5 Ways to Find a Planet (downloadable animations):
<https://exoplanets.nasa.gov/5-ways-to-find-a-planet/>
 - Exoplanet Travel Bureau (VR and Posters!):
<https://exoplanets.nasa.gov/alien-worlds/exoplanet-travel-bureau/>
 - Galaxy of Horrors (3d planets and Posters!):
<https://exoplanets.nasa.gov/alien-worlds/galaxy-of-horrors/>
-  NASAExoplanets
-  @NASAExoplanets
- Universe of Learning (PI STScI, Co-Is: IPAC, JPL, Sonoma State, Harvard SAO):
<https://www.universe-of-learning.org/>

Anya Biferno, Public Engagement Manager: anya.a.biferno@jpl.nasa.gov



Stay Connected with ExEP:

exoplanets.nasa.gov

[ExoPAGannounce](#) mailing list

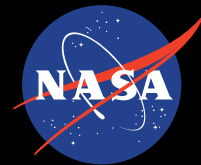
[StarshadeSIP](#) mailing list

gary.blackwood@jpl.nasa.gov

kendra.short@jpl.nasa.gov

karl.stapelfeldt@jpl.nasa.gov

eric.mamajek@jpl.nasa.gov



Jet Propulsion Laboratory
California Institute of Technology

jpl.nasa.gov